

AMENDMENTS TO THE DRAWINGS

A replacement formal drawing for Fig. 1 has been filed concurrently.

REMARKS

In view of the above amendments and following remarks, reconsideration and further examination are requested.

Initially, a replacement formal drawing has been provided for Fig. 1 so as to designate this figure as --Prior Art--.

The specification and abstract have been reviewed and revised to make editorial changes thereto and generally improve the form thereof, and a substitute specification and abstract are provided. No new matter has been added by the substitute specification and abstract.

Claims 1-6 have been canceled and claims 7-14 have been added. New claims 7-14 have been drafted taking into account the 35 U.S.C. § 112, second paragraph, issues raised by the Examiner, are believed to be free of these issues, and are otherwise believed to be in compliance with 35 U.S.C. § 112, second paragraph.

The instant invention pertains to a lip-type seal for withstanding pressure and sealing a space between a housing and a rotational shaft. The lip-type seal comprises an elastic seal ring including an annular fitted part and a lip part, with the annular fitted part to be fitted into a hole of the housing, and the lip part extending from the fitted part inwardly in a radial direction in the shape of a substantially conical ring that is to be brought into contact with the shaft. The lip-type seal also comprises a support ring including an annular joint part joined to the annular fitted part, and an annular supporting part, with the annular supporting part defining a hole through which the shaft is to pass, extending from a side of the annular joint part to a middle region of the lip part, and supporting the lip part, inwardly of the lip part, in the radial direction. Such a lip-type seal is generally known in the art, but suffers from drawbacks as expressed on pages 1-2 of the original specification.

Applicants have addressed and resolved these drawbacks by providing a unique lip-type seal. Specifically, as shown in Figures 4A and 4B, for example, the lip part 23 is tapered in cross section from an area 23b' at which non-contact with the annular supporting part 33 begins toward an end 23b" of the lip part, such that a value T0/T1 falls within 0.3 to 0.7, with T1 being a

thickness of the lip part at area 23b' and T0 being a thickness of the end 23b". New claim 7 is believed to be representative of Applicants' inventive lip-type seal.

Claims 1, 5 and 6 were rejected under 35 U.S.C. § 102(b) as being anticipated by Hosokawa et al., and claims 2-4 were rejected under 35 U.S.C. § 103(a) as being obvious over Hosokawa et al. Hosokawa et al. is not applicable with regard to the currently added claims for the following reasons.

Hosokawa et al. is based on a technical idea that a lip part is formed so as to prevent contact with a shaft over a large area (i.e. face contact) by restricting excessive deformation of the lip part caused by high pressure. However, the present invention is based on a technical idea that it is more desirable, from a viewpoint of durability, to expand a contact width of a lip part in a high pressure environment even though it is conventional common sense to maintain a line-contact state in order to secure sealability as shown in Hosokawa et al.

New claim 7 basically corresponds to a combination of former claims 1 and 2, and accordingly, Hosokawa will be discussed as it pertains to the rejection of claim 2.

In rejecting claim 2 over Hosokawa et al., the Examiner recognizes that Hosokawa et al. does not disclose the ratio of the thickness of the end of the lip part to the thickness of the lip part at the area at which non-contact with the support part begins, i.e T0/T1, being between 0.3 and 0.7. Thus, the Examiner took the position that the value of such ratio would have been obvious to one having ordinary skill in the art, absent some showing of unexpected results, since *In re Kulling* stands for the general proposition that discovering an optimum range of a result effective variable involves only routine skill in the art. This general proposition is not disagreed with; however, it is not believed to be applicable with regard th Hosokawa et al.

In this regard, though the drawings of Hosokawa et al. appear to show a lip part 13b that is tapered from where non-contact with supporting metal 12 begins to an end of the lip part, there is no discussion in Hosokawa et al. as to the purpose of, or the function to be performed by, the lip part being "tapered". As such, there is no indication from Hosokawa et al. that the tapering of the lip part is a "result effective variable". That is, there is no indication from Hosokawa et al. that a tapered lip part exhibits any benefits relative to a non-tapered lip part. Thus, because

Hosokawa et al. does not recognize the tapering of the lip part as a result effective variable, discovering an optimum range of this tapering would not have been obvious to one having ordinary skill in the art.

For the above reasons, it is respectfully submitted that the 35 U.S.C. § 103(a) rejection of claim 2 is in error, whereby claims 7-14 are allowable.

Additionally, unexpected results exist in that the inventors have gone against what is conventional in the art (i.e. line-contact between the seal and a shaft), and have provided a seal with a specific configuration that allows for a greater area of contact between the seal and the shaft. In this regard, the inventors have found a critical condition of upper and lower limits concerning the value of the ratio T₀/T₁ based on results of an endurance test. Namely, if the end of lip part is too thin the “scooped phenomenon” has occurred as shown in Fig. 7A, and if the end of lip part is too thick the “toppling phenomenon” has occurred as shown in Fig. 7B.

Specifically, as understood from Fig. 8, which shows results of an endurance test while varying the value of T₀/T₁, when the value is greater than about 0.65 large wear of the seal such as caused by the “toppling phenomenon” as shown in Fig. 7B has occurred, and when the value is not greater than about 0.35 large wear of the seal such as caused by the “scooped phenomenon” as shown in Fig. 7A has occurred. Thus, the inventors have determined that when the value of T₀/T₁ is in the range of 0.3 to 0.7, realized is an amount of wear that is sufficiently permissible. That is, when the value is within this range a bending strength of the lip part is uniform, whereby wear resulting from the “scooped phenomenon” is small and wear resulting from the “toppling phenomenon” is prevented. Accordingly, sealability and durability of the seal are improved.

For reasons analogous to those presented above, new claim 8 is believed to be patentable in its own right. And, the annular supporting part being bent away from the lip part as recited in claim 13 is not taught or suggested by Hosokawa et al., whereby claim 13 is also believed to be patentable in its own right.

In view of the above amendments and remarks, it is respectfully submitted that the present application is in condition for allowance and an early Notice of Allowance is earnestly solicited.

If after reviewing this Amendment, the Examiner believes that any issues remain which must be resolved before the application can be passed to issue, the Examiner is invited to contact the Applicants' undersigned representative by telephone to resolve such issues.

Respectfully submitted,

Koichiro OIYAMA et al.

By: 
Joseph M. Gorski
Registration No. 46,500
Attorney for Applicants

JMG/nka
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
January 4, 2007